A survey of large forest owls in State Forests of south-western New South Wales, Australia

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ABSTRACT

A survey of large forest owls was conducted at 261 survey points within State forests of south-western New South Wales, and an additional 10 sites within the Wagga Wagga Local Government Area in May-June 2004. A combination of listening, playback of recorded calls and spotlighting was used. Barking Owls *Ninox connivens* were recorded primarily from River Red Gum *Eucalyptus camaldulensis* vegetation associations (n = 8) and once from mixed Western Grey Box *Eucalyptus microcarpa* / River Red Gum association. No records of the Powerful Owl *N. strenua* or the Masked Owl *Tyto novaehollandiae* were obtained. Four other nocturnal bird species were recorded during the surveys: Southern Boobook *N. novaeseelandiae* (n = 74), Barn Owl *T. alba* (n = 61), Australian Owlet-nightjar *Aegotheles cristatus* (n = 46) and Tawny Frogmouth *Podargus strigoides* (n = 8). In light of the low frequency of Barking Owls recorded in this and other recent surveys, consideration needs to be given to upgrading the classification of the Barking Owl under the NSW Threatened Species Conservation Act to "Endangered" subject to the undertaking of more comprehensive whole-of-landscape survey, including private lands and conservation reserves.

Key words: Barking Owl, Powerful Owl, Masked Owl, distribution, conservation, threatened species

Introduction

The Barking Owl *Ninox connivens connivens* (southern subspecies), Powerful Owl *N. strenua* and Masked Owl *Tyto novaehollandiae novaehollandiae* (southern subspecies) have been recorded historically within the south-west of New South Wales (NSW) (Hobbs 1961; Fleay 1968; Debus and Rose 1994; Debus 1997a; Higgins 1999) and northern Victoria (Higgins 1999). Within this region, 88% (n = 106) of large forest owl records contained in the combined atlas databases of Birds Australia (old and new atlas), the Atlas of Victorian Wildlife and the NSW National Parks and Wildlife Atlas (complete data sets to March 2004) are of the Barking Owl. Amongst these same database sets fewer than 10 records exist for each of the Powerful Owl and Masked Owl.

The distribution of the Barking Owl and Masked Owl inland of the Great Dividing Range is particularly associated with riparian vegetation along watercourses (Kavanagh *et al.* 1995; Higgins 1999; Garnett and Crowley 2000; Shelly 2006). Regarding the Barking Owl, Hobbs (1961) writes "*Apparently restricted to the red gum timber along the rivers where it is not uncommon, being found throughout the area.*" The species, however, appears to have experienced a widespread decline in abundance (Debus 1997a; Taylor *et al.* 2002; NPWS 2003; NSW Department of Environment and Conservation 2005). The area of occupancy of this subspecies has declined by more than half its original range (Garnett and Crowley 2000), and recent surveys across south-western NSW have failed to record any significant concentrations of this species (Kavanagh and Stanton 1998; Taylor and Herring 2002).

Records for the Masked Owl include those from Gunbar (North 1911), Deniliquin – nesting in January 1955 (Hobbs 1961), Whitton and Jerilderie (Debus 1993) and Willandra National Park (Higgins 1999). Webster *et al.* (2003) suggests the Masked Owl appears now to be only an infrequent visitor to south-western New South Wales. Likewise, the distribution of the Powerful Owl in these inland areas may also be influenced by the presence of riparian vegetation along major rivers (Tzaros *et al.* 2003) where it is known from only a few scattered records in northern Victoria (Higgins 1999; R. Webster pers. obs.).

All three species are listed as vulnerable in New South Wales (NSW *Threatened Species Conservation Act* 1995). The major threat to large forest owls has been the clearing, fragmentation and structural degradation of their habitat. These actions have resulted in the removal of potential foraging, roosting and breeding habitat (Higgins 1999; NPWS 2000).

Based on the relevance of owl conservation requirements in guiding land management (e.g. Kavanagh 2002; Liddelow *et al.* 2002), the need for comprehensive information on owl distribution for recovery planning, and the potential benefit to broader biodiversity management issues, owl research was viewed as a high priority in the study area. This project was set within the broader context of biodiversity management as part of Forests New South Wales (FNSW) Ecologically Sustainable Forest Management Program, the

Department of Environment and Conservation (formerly NSW National Parks and Wildlife Service, but now Department of Environment and Climate Change since April 2007) Threatened Species Recovery Plans for large forest owls, and the licensing of forestry activities under the NSW *Threatened Species Conservation Act* 1995. Recovery plans for large forest owls (NPWS 2003; NSW Department of Environment and Conservation 2005) identified investigative surveys on public lands (i.e. National Parks, State Forests and Travelling Stock Reserves) and private lands as key recovery actions required to better understand these species.

The aim of the present study was to document the regional distribution of large forest owls in State forests in south-western New South Wales and provide a first step in the implementation of this recovery action.

Methods

Study area and selection of survey sites

The survey was conducted within Forests NSW estate, in the area between the Murray and Murrumbidgee Rivers, west of the Hume Highway as far west as Lake Victoria (approximately 50 km west of Wentworth). A total of 271 study sites were surveyed, 167 along the Murray River between Corowa and Lake Victoria, 24 along the Murrumbidgee River between Wagga Wagga and Hay, 70 between these two rivers, and 10 within the Wagga Wagga Local Government Area (Figure 1, Table 1).

The location of survey sites was generated using a geographic information system (ArcMap version 8.3) based on the following criteria: (i) sites were placed along roads and tracks; (ii) where large expanses of forest had no vehicle access, walking surveys were considered if results suggested their necessity; (iii) sites were placed no closer than 3 km apart (reducing the possibility of the same bird(s) being detected at more than one site); (iv) sites were placed no further than 5 km apart (reducing the possibility of birds being missed); and (v) the survey team coordinated with each other so that interference between playback was avoided. This selection method allowed complete survey coverage of the target area, and comprised sites in mesic and xeric habitats, close to rivers, major creek systems, and other wetlands, as well as the forest edge and forest interior. Sites surveyed for the Wagga Wagga LGA were pre-selected by the Wagga Wagga City Council.

Detection method and playback sequence

Field surveys were undertaken between 3 May and 16 June 2004. Though the focus of the survey was on the distribution of the Barking Owl, both the Masked Owl and Powerful Owl were also considered. At each site, a five minute listening period was conducted in order to detect 'voluntary' calling of resident birds. This was followed by a call playback session consisting of five minutes of intermittent calls for each of the three targeted species, with listening periods interspersed between calls. Calls of the Powerful Owl were played first to accommodate their slower response time (T. Soderquist pers. com.), followed by the Masked Owl, and finally the Barking Owl.

The call playback sessions were then followed by a 20-minute period of listening during which spotlighting was conducted on a 1 ha circular plot (i.e. approx. 57 m radius). Therefore, between 40 and 50 minutes was spent at each site.

Other information recorded, particularly for the target species included: species detected, number of individuals, response intensity, initial distance and direction of responses, and also additional vertebrates responding or otherwise detected.

Results

Large Forest Owls

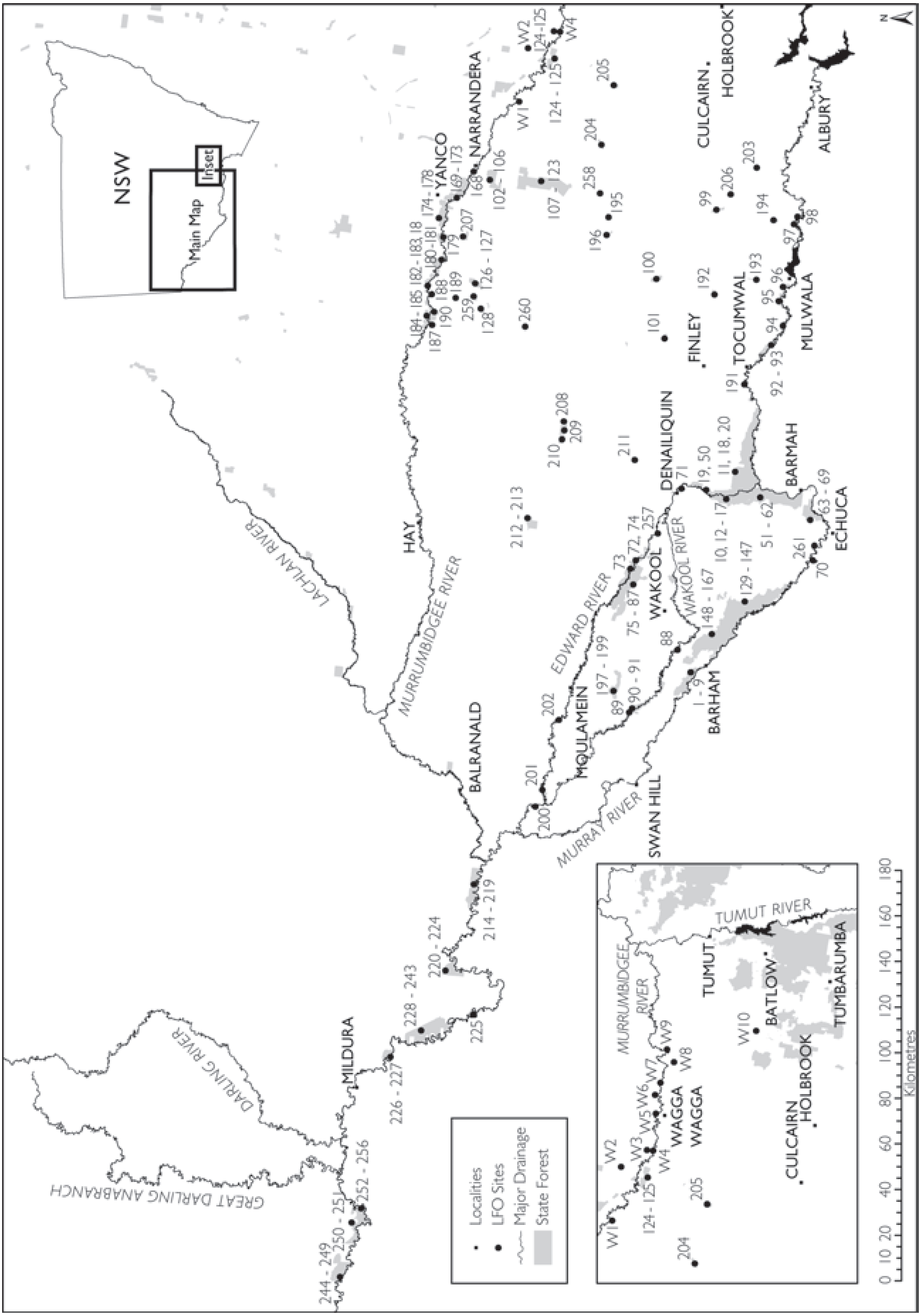
The Barking Owl was recorded at seven of the 261 sites (2.7 %) surveyed in State Forests of south-western New South Wales. A further two incidental records were obtained during the survey period. Barking Owls were recorded within Moira (2 sites), Bama (2 sites), Cottadidda (1 site), Berry Jerry (1 site), and Perricoota State Forests (1 site + 1 incidental), and MIA 1 (1 incidental). No records of Powerful Owl or Masked Owl were obtained during the survey. No large forest owl records were recorded from the additional 10 sites surveyed within the Wagga Wagga LGA.

With records from only nine locations (including two incidental records), rigorous statistical analysis was not possible. However, eight of the nine sites where Barking Owls were recorded contained River Red Gum *Eucalyptus camaldulensis* as the dominant canopy tree (Figure 2). The remaining site comprised a mixed Western Grey Box *E. microcarpa* / River Red Gum association.

These sites were located within the extensive riverine forests of the Murray (seven sites) and Murrumbidgee Rivers (two sites). Seven of the sites were located in the forest and woodland interior, including: one along the Murray River corridor (incidental record), one on the forest edge with Moira Lake and three along creeks / drainage lines within the forest, with the remaining two being from within the forest. Of the two sites at the forest edge, one was along the Murrumbidgee River corridor (incidental record) and both were in areas where there were areas of extensive contiguous woodland dominated by River Red Gum. No records during the study came from the drier forest types such as the Cypress Pine *Callitris* and Box eucalypt associations (Figure 3) away from these floodplain forests and woodlands.

Response of large forest owls to playback

Barking Owls responded to call playback during the surveys. The response obtained from each site was of individual birds. The well-known strong response of the Barking Owl to call playback (Debus 1997a,b; Higgins 1999) was partly reflected in the survey results. On two occasions, birds called shortly after and during the Powerful Owl call sequence, both strongly. On a third occasion, the response was by a pair duetting, obtained during the final listening/spotlight session. This was the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MOULAMEIN
SWAN HILL
BARHAM
WAKOOL
DENAILIQUIN
BARMAH
ECHUCA
FINLEY
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MULWALA
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Figure 1. Location of study sites.

Table 1: Location of study sites

Site Number	State Forest	Area (ha)	Site Number	State Forest	Area (ha)
1-9	Campbell's Island SF	3819.4	194	Ringwood Tank SF	231.8
10, 12-17	Gulpa Island SF	5469.9	195	Widgiewa SF	204.1
11, 18, 20-49	Millewa SF	20991.0	196	Lake Urana SF	213.6
19, 50	Tuppal SF	1003.9	197-199	Niemur FS	1609.6
51-62	Moira SF	10650.7	200-201	Kyalite SF	612.1
63-69	Bama SF	3198.3	202	Berambong SF	270.8
70	Benarca SF	211.9	203	Kentucky SF	164.5
71	Deniliquin SF	428.2	204	Brookong SF	332.9
72, 74	Morago SF	1194.4	205	Milbrulong SF	381.5
73	Banangalite SF	1294.9	206	Lonesome Pine SF	302.4
75-87	Werai SF	9317.4	207	Banandra SF	762.1
88	Whymoul SF	396.8	208	Steam Plains SF	327.5
89	Wetuppa SF	1033.0	209	Edgar SF	637.4
90-91	Noorong SF	1597.7	210	Puckawidgee SF	427.2
92-93	Barooga SF	1214.8	211	Tholobin SF	196.8
94	Cottadidda SF	686.3	212-213	Booroorban SF	1441.2
95	Boomanoomana SF	995.9	214-219	Maine SF	5074.3
96	Mulwala SF	501.3	220-224	Euston SF	3268.6
97-98	Collendina SF	562.0	225	Ki SF	722.4
99	Coreen SF	377.9	226-227	Gol Gol SF	1395.4
100	Palmer SF	723.9	228-243	Mallee Cliffs SF	10128.6
101	Mairjimmy SF	453.9	244-249	Lake Victoria SF	4431.2
102-106	Gillenbah SF	3122.8	250-251	Wangumma SF	1635.2
107-123	Buckingbong SF	11347.9	252-256	Moorna SF	3289.7
124-125	Berry Jerry SF	1342.3	257	Stevens Weir SF	97.6
126-127	Boona SF	1186.9	258	Cullivel SF	165.1
128, 259	Bretts SF	735.3	260	Kulki SF	170.2
129-147	Perricoota SF	16019.2	261	Moama SF	38.9
148-167	Koondrook SF	15143.9			
168	Narrandera SF	203.3			
169-173	MIA I	3184.9			
174-178	MIA II	2543.8		Wagga Wagga LGA	
179	MIA III	739.1	W1	Pipers Res.	
180-181	Cuba SF	1643.0	W2	Cottee Road Res.	
182-183, 186	Willbriggie SF	922.3	W3	Euberta Res.	
184-185	Benerembah SF	1131.1	W4	Kohlhagen Beach Res.	
187	Yarrada SF	1017.9	W5	North Wagga Flats	
188	Uri SF	267.3	W6	Wantabadgery Road Res.	
189	Ugobit SF	223.8	W7	Shanty	
190	Cararbury SF	235.2	W8	Borambola	
191	Woperana SF	258.2	W9	Yabtree Res.	
192	Berrigan SF	286.1	W10	Humula Recreation Res.	
193	Wahgunyah SF	327.3			

Study Sites (SF = State Forest, Res. = Reserve)

only instance where more than one bird was recorded at a site. However, the level of intensity in responses recorded on four of the seven occasions were either a single bark (one occasion during Barking Owl sequence), or a single double bark (three occasions – once after Powerful Owl sequence, once after Masked Owl sequence, and once during the final listening period). Barking Owls responded only by call, and did not approach the surveyor.

Figure 2. River Red Gum forest, Moira State Forest (site 57).

Figure 3. White Cypress Pine *Callitris glaucophylla* – Yellow Box *Eucalyptus melliodora* woodland, Ugobit State Forest (site 189).

Of the two incidental records obtained, both were by voluntary calls, and both before 18:00 hours (17:55 and 17:45 hours respectively). The first was heard calling initially with a single bark, which then rolled into a low growl; the second bird calling with a double-note call twice. On neither occasion did the birds respond to call playback at the nearest survey site (<1.5 km away).

Other vertebrate species encountered

A total of 190 observations of four other species of nocturnal bird were recorded during the survey from 111 of the 271 sites. No species of nocturnal bird was recorded at 160 or 59 % of sites surveyed.

The most common and widespread species of nocturnal bird detected during the survey was the Southern Boobook *Ninox novaeseelandiae* (Table 2). The Barn Owl *Tyto alba* (including one incidental record) and the Australian Owlet-nightjar *Aegotheles cristatus* were also widespread across the survey area. The Tawny Frogmouth *Podargus strigoides* was recorded at fewer sites (Table 2). Three incidental records of the Tawny Frogmouth were also obtained. Playback for these species was not part of the survey technique.

Table 2. The total encounters of each species of nocturnal bird encountered and the number of sites that each species was present on during the survey period.

Species	Encounters	Sites	% of sites
Barking Owl	7	7	2.6
Southern Boobook	74	56	20.7
Barn Owl	62	48	17.7
Tawny Frogmouth	8	5	1.8
Australian Owlet-nightjar	46	30	11.0
TOTAL	197		

The Common Brushtail Possum *Trichosurus vulpecula* was the most commonly recorded species of arboreal marsupial during the survey, being recorded at 34.3 % of survey sites. In comparison, the Common Ringtail Possum *Pseudocheirus peregrinus* was less numerous, and recorded from only 5.2 % of survey sites (Table 3). Although the Common Brushtail Possum was recorded from all vegetation associations across the study area, all except one record of the Common Ringtail Possum were from River Red Gum associations, with the one other being from White Cypress-pine *Callitris glaucophylla* / Blakely's Red Gum *Eucalyptus blakelyi* association.

Other, less commonly recorded species of arboreal marsupial included the Feathertail Glider *Acrobates pygmaeus*, Squirrel Glider *Petaurus norfolcensis*, Sugar Glider *Petaurus breviceps* (all in River Red Gum associations) and Water Rat *Hydromys chrysogaster* (in water). The ground-dwelling Fat-tailed Dunnart *Sminthopsis crassicaudata* was recorded during the survey in White Cypress-pine association (Table 3). It was not possible to determine whether these prey species were limiting the distribution of the Barking Owl due to the few owl records in this study.

Table 3. The total encounters of each species of mammal encountered and the number of sites that each species was present on during the survey period.

Species	Encounters	Sites	% of sites
Fat-tailed Dunnart	1	1	0.4
Common Brushtail Possum	164	93	34.3
Sugar Glider	3	3	1.1
Squirrel Glider	2	1	0.4
Common Ringtail Possum	19	14	5.2
Feathertail Glider	1	1	0.4
Water Rat	3	1	0.4

Discussion

Conservation of large forest owls across the landscape requires knowledge of species' distributions, abundances, ecological requirements, population dynamics and threatening processes. Interpretation of owl ecology and distribution is enhanced by broadscale surveys across all land tenures. This survey was restricted to FNSW estate, and therefore did not include areas of land managed by Department of Environment and Climate Change (including National Parks and Nature Reserves), Rural

Lands Protection Boards (including Travelling Stock Reserves) or private land. Therefore, the limitations of this study (restricted site distribution, one visit per site) and the paucity of records obtained, restricted the ability to undertake rigorous statistical analysis.

The Barking Owl was recorded at seven of the 261 sites (2.7 %) surveyed in State Forests of south-western New South Wales. A further two incidental records were obtained during the survey period. In this survey, the Barking Owl was the only species of large forest owl recorded. Within the study area, the Barking Owl was mainly recorded from the larger forest remnants (>1000 ha) associated with the two major rivers, which were adjacent to significant areas of remnant vegetation on private property. The species was recorded only once from a smaller forest remnant (<1 000 ha) associated with the major river systems. The results are consistent with those of Debus (2001), where in surveys on the western slopes of NSW, the Barking Owl was recorded most frequently in the largest forest remnants on public land or large remnant areas encompassing private land and public land. Furthermore, during our survey, the Barking Owl was not recorded from the drier forest types of the plains; this included failing to detect Barking Owls within the Box/*Callitris* forest of Buckingbong State Forest where Taylor and Herring (2002) recorded the species from two localities in 2000.

All three species targeted during this survey are known to call or can be induced to call in virtually all months of the year (Debus 1995; Debus 1997a), but the intensity of spontaneous calling or response may vary seasonally (Debus 1995). Barking Owls have been reported calling throughout the year (Debus 1997a). Debus (1997b) indicated that, if present, the responsiveness of the Barking Owl to playback should be highly effective, even in the non-breeding season, with greatest frequency in July-August. The well-known strong response to call playback (Debus 1997b; Higgins 1999) was also reported in surveys conducted during autumn and winter in forests and woodlands of central western NSW (including the Pilliga area) where responses recorded included birds flying overhead, hooting loudly and persistently (Milledge 2002). However, where Barking Owls were encountered in the present study of south-western NSW, birds were found to be reluctant to respond to call-playback and did not approach or fly in overhead.

The use of call playback and its effectiveness in detecting birds has been studied in a range of owl species (i.e. Kavanagh and Peake 1993; Debus 1995; Navarro *et al.* 2005; Wintle *et al.* 2005). However, the focus of these studies was primarily limited to temporal factors, weather and technique. Few other investigations have looked at the dynamics of the owl populations. For example, Redpath (1994) investigated response levels in known populations of Tawny Owls *Strix aluco* in relation to population density. Redpath (1994) found that in areas where Tawny Owls were at low density, exposure to both neighbours and strangers was lower and birds responded faster and more vigorously. In another study, Martinez and Zuberogotia (2002) describe the presence of unpaired 'floaters', individuals who do not hold a territory and may remain silent within a population. This range of influences highlights the need to conduct multiple visit surveys to guard against false negatives (Wintle *et al.* 2005).

Barking Owls in the study area appear to: (i) occur at a very low density within this fragmented landscape; (ii) are now less numerous than the species was historically (Hobbs 1961); and (iii) preferentially select large forest remnants, which are therefore likely to be important for its regional survival. Combined with results from past surveys in southern NSW (Kavanagh and Bamkin 1995; Kavanagh and Stanton 1998; Taylor and Herring 2002), the results of this survey add weight to the importance of the Pilliga area of central western NSW for the Barking Owl not only as a regional stronghold (Debus 2001), but as a major stronghold for this species in NSW (Milledge 2002). The results of this and other recent surveys across southern NSW demonstrate the need for comprehensive 'whole-of-landscape' surveys, including private land and conservation reserves managed by DECC, in order to determine the extent and population size of the Barking Owl across NSW.

The Powerful Owl and Masked Owl were not detected during this survey despite the use of appropriate sampling techniques. Although the Powerful Owl is known to be resident in nearby riverine woodland on the lower reaches of the Ovens River (C. Tzaros pers. comm.), this study suggests that the forests and woodlands of south-western NSW do not provide important habitat for the species. However, because of survey limitations the results do not exclude such birds as the Ovens River pair, or others, moving north of the Murray River to utilise areas of forest and woodland during foraging activities, or juveniles from these pairs dispersing in search of new territories. Though historic records show the Masked Owl to be present in the region (Higgins 1999), including observations of breeding (Hobbs 1961), this survey supports the suggestion of Webster *et al.* (2003) that the species is now only an infrequent visitor to the region. Debus (2001), though, cautions that dispersing immature birds may be easily mistaken for Barn Owls in inland agricultural areas, owing to the morphological similarity of Barn Owls and male Masked Owls of the pale or intermediate morph. The presence of the Masked Owl across south-western NSW may be better determined by targeted and landscape-wide surveys.

It would be useful to survey large forest owls in the study area on at least another occasion to give greater confidence in the results obtained. The expansion of the survey into other land tenures, including areas of public land (i.e. National Parks and Travelling Stock Reserves) and freehold land, would provide a more complete, and essential, picture of the current distribution of the Barking Owl and where areas of suitable habitat occur. Further investigation of the ecology of the Barking Owl is required to determine (i) nest and roost site characteristics, territory size and landscape usage; (ii) habitat quality and factors affecting quality; (iii) monitoring of breeding success; and (iv) the development of realistic and effective conservation actions.

Acknowledgements

Todd Soderquist of the NSW Department of Environment and Climate Change, Western Directorate assisted with survey design. Natasha Schedvin, Todd Soderquist and Rod Kavanagh provided valuable information on large owl ecology generally. The Western Region of Forests NSW, particularly Pat Tap and Stephen Campbell, provided helpful information and facilitated the permission to survey Cypress Pine forests in their management area. Paul Childs, Brian Holden, Ian Campbell and Elizabeth Parker assisted with the fieldwork, and Shane Dillon assisted with maps and spatial analysis. David Stewart of Nature Sound, Mullumbimby prepared the CD of owl calls used for playback during the survey. Fieldwork was carried out under the relevant permits and licences provided by the NSW National Parks and Wildlife Service, Forests NSW and the Director General of NSW Agriculture's Animal Ethics Committee. This paper benefited from the useful comments provided by Rod Kavanagh and Todd Soderquist.

References

Atlas of Australian Birds database (new and old). 2004. Birds Australia, Melbourne.

Atlas of New South Wales Wildlife database. 2004. Department of Environment and Conservation, Hurstville.

Atlas of Victorian Wildlife database. 2004. Department of Sustainability and Environment, Heidelberg, Vic.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R.,2002. *The Atlas of Australian Birds (1998-2001).* Environment Australia Natural Heritage Trust Fund, Canberra.

Debus, S.J.S. 1993. The Mainland Masked Owl *Tyto novaehollandiae*: a review. *Australian Bird Watcher* **4**: 168-191.

Debus, S.J.S. 1995. Surveys of large forest owls in northern New South Wales: methodology, calling behaviour and owl responses. *Corella* **19**: 38-50.

Debus, S.J.S. 1997a. The Barking Owl in New South Wales. *Australian Birds Supplement* **30**: 53-80.

Debus, S.J.S. 1997b. Vocal behaviour of the Southern Boobook *Ninox novaeseelandiae* and other nocturnal birds. Pp. 71-85 in Australian Raptor Studies II, edited by G. Czechura and S. Debus. Birds Australia Monograph 3, Birds Australian, Melbourne.

Debus, S.J.S. 2001. Survey of the Barking Owl and Masked Owl on the North-west Slopes of New South Wales. *Corella* **25**: 5-11.

Debus, S.J.S. and Rose, A.B. 1994. The Masked Owl *Tyto novaehollandiae* in New South Wales. *Australian Birds Supplement* **28**: 40-64.

Fleay, D.,1968. *Nightwatchmen of Bush and Plain*. The Jacaranda Press, Brisbane.

Garnett, S. and Crowley, G.M. 2000. *Action Plan for Australian Birds 2000*. Environment Australia and Birds Australia, Canberra.

Higgins, P.J. (ed). 1999. *Handbook of Australian, New Zealand & Antarctic Birds. Volume 4 Parrots to Dollarbird.* Oxford University Press, Melbourne.

Hobbs, J.N. 1961. The birds of south-west New South Wales. *Emu* **61**: 21-55.

Kavanagh, R.P. 2004. Distribution and conservation status of possums and gliders in New South Wales. Pp. 130-148 in The Biology of Australian Possums and Gliders, edited by R.L. Goldingay and S.M. Jackson. Surrey Beatty and Sons, Chipping Norton.

Kavanagh, R.P., Debus, S.J.S., Rose, A.B. and Turner, R.J.,1995. Diet and habitat of the Barking Owl *Ninox connivens* in New South Wales. *Australian Bird Watcher* **16**: 137-144.

Kavanagh, R.P. and Bamkin, K.L. 1995. Distribution of nocturnal forest birds and mammals in relation to the logging mosaic in south-eastern New South Wales, Australia. *Biological Conservation* **71**: 41-53.

Kavanagh, R.P. and Peake, P. 1993. Survey procedures for nocturnal birds: an evaluation of variability in census due to temporal factors, weather and technique. Pp. 86-100 in *Australian Raptor Studies*, edited by P. Olsen. Australian Raptor Association. R.A.O.U. Melbourne.

Kavanagh, R.P. and Stanton, M.A. 1998. Nocturnal forest birds and arboreal marsupials of the southwestern slopes, New South Wales. *Australian Zoologist* **30**: 449-466.

Liddelow, G.L., Wheeler, I.B. and Kavanagh, R.P. 2002. Owls in the South-West Forests of Western Australia. Pp. 107-115 in Ecology and Conservation of Owls, edited by I. Newton, R. Kavanagh, J. Olsen and I. Taylor. CSIRO Publishing, Melbourne.

Martinez, J.A. and Zuberogoitia, I. 2002. Factors affecting the vocal behaviour of Eagle Owls *Bubo bubo*: effects of sex and territorial status. *Ardeola* **49**: 1-9.

Milledge, D.R. 2002. A survey of large owls in the Cypress Pine – Ironbark forests and woodlands of central western NSW. Consultants report to the NSW National Parks and Wildlife Service, Hurstville.

Navarro, J., Minguez, E., Garcia, D., Villacorta, C., Botella, F., Sanchez-Zapata, J.A., Carrete, M. and Gimenez, A. 2005. Differential effectiveness pf playbacks for Little Owls (*Athene noctua*) surveys before and after sunset. *Journal of Raptor Research* **39**: 457-461.

North, A.J. 1911. *Nests and Eggs of Birds Found Breeding in Australia and Tasmania*. Vol. 3, Australian Museum, Sydney.

NPWS 2000. Wildlife Management manual for the Riverina Plains. NSW National Parks and Wildlife Service, Hurstville, NSW.

NPWS 2003. *Draft Recovery Plan for the Barking Owl*. NSW National Parks and Wildlife Service, Hurstville, NSW.

NSW Department of Environment and Conservation, 2005. *Draft Recovery Plan for Large Forest Owls: Powerful Owl Ninox strenua Sooty Owl Tyto tenebricosa Masked Owl Tyto novaehollandiae*. NSW DEC, Sydney, NSW.

Redpath, S.M. 1994. Censusing Tawny Owl *Strix aluco* by the use of imitation calls. *Bird study* **41**: 192-198.

Shelly, D. 2006. Observations on the ecology of the Barking Owl *Ninox connivens* within the lower Macquarie River floodplain of New South Wales. *Australian Zoologist* **33**: 283-289.

Taylor, I.R., Kirsten, I and Peake, P.,2002. Distribution of Barking Owls (*Ninox connivens*) in central Victoria. Pp. 107-115 in Ecology and Conservation of Owls, edited by I. Newton, R. Kavanagh, J. Olsen and I. Taylor. CSIRO Publishing, Melbourne.

Taylor, I.R. and Herring, M. 2002. Distribution and habitat of the Barking Owl *Ninox connivens* in southern New South Wales. Consultants report to the NSW National Parks and Wildlife Service, Hurstville.

Tzaros, C.L., Weston, M.A. and Quin, D.G. 2003. North-west Victorian range expansion and unusual habitat use of the Powerful Owl *Ninox strenua. The Victorian Naturalist* **120**: 61-64.

Webster, R., Belcher, C. and Leslie, D. 2003. A survey for threatened fauna in south-western New South Wales. *Australian Zoologist* **32**: 214-228.

Wintle, B.A., Kavanagh, R.P., McCarthy, M.A. and Burgman, M.A. 2005. Estimating and dealing with detectability in occupancy surveys for forest owls and arboreal marsupials. *Journal of Wildlife Management* **69**: 905-917.